DOCUMENT RESUME

ED 367 793 CE 065 786

TITLE	Solar Energy. 7th and 8th Grade Agriculture Science Curriculum. Teacher Materials.
INSTITUTION	Southern Illinois Univ., Carbondale. Dept. of Agricultural Education and Mechanization.
SPONS AGENCY	Illinois State Board of Education, Springfield. Dept. of Adult, Vocational and Technical Education.
PUB DATE	93
NOTE	93p.; For other titles in this set, see CE 065 784-789.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	*Agricultural Education; Agricultural Production; Alternative Energy Sources; Classroom Techniques; Competence; Competency Based Education; Construction Materials; Course Content; Curriculum Guides; Grade 7; Grade 8; Heat; Integrated Curriculum; Junior High Schools; Learning Activities; Lesson Plans; Power Technology; *Solar Energy; Teaching Methods; Test Items; Transparencies; Units of Study
IDENTIFIERS	Agricultural Sciences

ABSTRACT

This curriculum guide, the third in a set of six, contains teacher and student materials for a unit on solar energy prepared as part of a seventh- and eighth-grade agricultural science curriculum that is integrated with science instruction. The guide contains the state goals and sample learning objectives for each goal for students in grades 8-10 and a teacher presentation outline for the unit. The unit, which begins by listing the agricultural practices and science concepts to be taught, along with activities and applications, contains the following components: teaching steps, lesson outlines, teacher's presentation outlines for each day, student information guide, terms and definitions, worksheets, student activity note sheets, student activity information sheets, student activity record sheets, quizzes, practice problems, and 10 transparency masters. Teacher's activity sheets and tests have answers provided. The unit covers the following topics: drying of agricultural and horticultural crops; space heating of agricultural facilities; production of biomass as an energy source; and production of ethanol and methanol. (KC)

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ED 367 793

7th and 8th Grade Agriculture Science Curriculum

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Teacher Materials

Solar Energy

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1. Heat Energy
2. Electromagnetic Spectrum
3. Solar Energy
4. Mechanical Advantage
5. Electrical Energy
6. Energy Conservation

CE 065 786

This publication was supported by FCAE/IAVAT/ILCAE/ICAE/FFA and was produced at Southern Illinois University at Carbondale. Funding was provided by ICAE and DAVTE/ISBE.

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ALTERNATIVE ENERGY SOURCES
BIOLOGICAL AND PHYSICAL SCIENCES
STATE GOAL FOR LEARNING 1

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical and contemporary technological society.

SAMPLE LEARNING OBJECTIVES FOR GOAL 1

By the end of GRADE 8, students should be able to:

C3. Use the fundamental units of length, mass, and time found in the metric system of measurement.
I1. Recognize how the sun affects air temperatures and pressures.

By the end of GRADE 10, students should be able to:

G1. Recognize that good conservation practices depend on understanding the balance between living things and their environment.

STATE GOAL FOR LEARNING 2

As a result of their schooling, students will have a working knowledge of the social and environmental implication and limitations of technological development.

SAMPLE LEARNING OBJECTIVES FOR GOAL 2

By the end of GRADE 8, students should be able to:

B2. Understand the dependence of society on geologic resources.
B3. Understand the positive and negative aspects of the consumption of renewable and nonrenewable resources.
B4. Relate our future energy supply the finding new sources and wise use of current supplies.
E1. Contrast the present limitations of the earth's natural resources with consumer demands.

By the end of GRADE 10, students should be able to:

B2. Identify technologies that use renewable energy resources.
B3. Relate future energy to the need for new resources.

STATE GOAL FOR LEARNING 3

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their application in simple research projects.

SAMPLE LEARNING OBJECTIVES FOR GOAL 3

By the end of GRADE 8, students should be able to:

A1. Compare experimental data to those obtained by others.
A2. Recognize that experimental results are replicable.
A5. Demonstrate effective participation as a member of a laboratory group.
B1. Relate hypotheses or working assumptions in a concise manner.
B2. Demonstrate alternative procedures for solving a problem.
B3. Understand the need to acquire, organize, and evaluate data.
B5. Demonstrate accurate measuring techniques.
B6. Relate a laboratory procedure that another student can follow.

By the end of GRADE 10, students should be able to:

A1. Replicate the results of an experiment.
A2. Recognize that their experimental results must be open to the scrutiny of others.
A5. Evaluate reasons for obtaining conflicting data.
B3. Demonstrate the ability to draw conclusions from collected data.
B4. Demonstrate various ways to display the same data.

STATE GOAL FOR LEARNING 4

As a result of their schooling, students will have a working knowledge of the processes, techniques, methods, equipment and available technology of science.

SAMPLE LEARNING OBJECTIVES FOR GOAL 4

By the end of GRADE 8, students should be able to:

A1. Recognize the need for appropriate instruments to aid in observation.
C1. Recognize an inference based upon experimental observation.
D1. Evaluate the validity of a prediction through experimentation.
E1. Use standard units to measure properties of objects.
F1. Report the results of an experiment using tables and graphs.
J1. Identify the variables in an experiment and suggest ways to control them.

By the end of GRADE 10, students should be able to:

D1. Revise a prediction on the basis of additional information.

E1. Identify appropriate methods of measurement for a given task.
F1. Analyze the results of an experiment.

PHYSICAL DEVELOPMENT
STATE GOAL FOR LEARNING 3

As a result of their schooling, students will be able to understand consumer health and safety, including environmental health.

SAMPLE LEARNING OBJECTIVES FOR GOAL 3

By the end of GRADE 8, students should be able to:

A2. Perform with appropriate safety equipment in safe environments.
G1. Know safety procedures needed in schools and the home to prevent accidents.

By the end of GRADE 10, students should be able to:

A2. Perform with appropriate safety equipment in safe environments.

LANGUAGE ARTS
STATE GOAL FOR LEARNING 4

As a result of their schooling, students will be able to use spoken language effectively in formal and informal situations to communicate ideas and information and to ask and answer questions.

SAMPLE LEARNING OBJECTIVES FOR GOAL 4

By the end of GRADE 8, students should be able to:

C2. Distinguish among statements of observation, opinion, and judgment.

MATHEMATICS
STATE GOAL FOR LEARNING 1

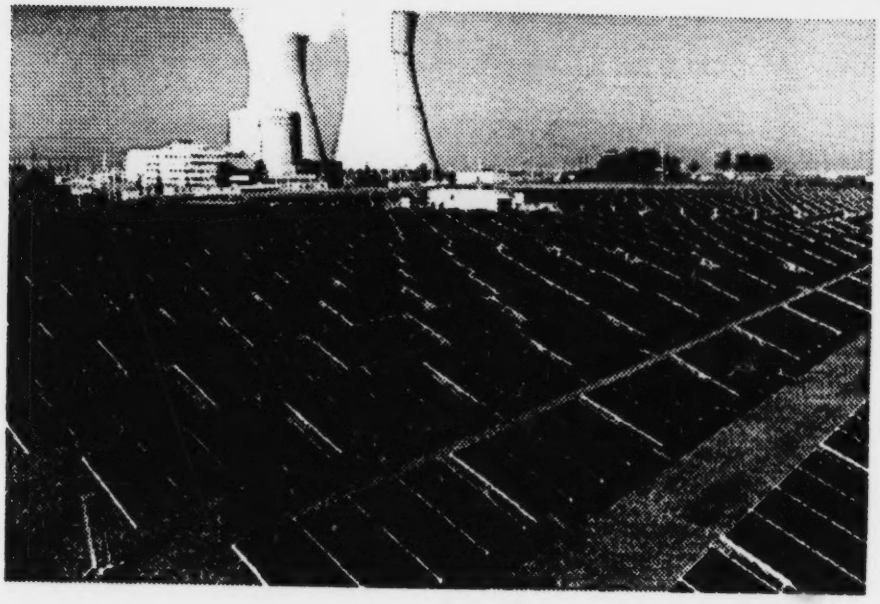
As a result of their schooling, students will be able to perform the computations of addition, subtraction, multiplication, and division using whole numbers, integers, fractions, and decimals.

SAMPLE LEARNING OBJECTIVES FOR GOAL 1

By the end of GRADE 8, students should be able to:

B3. Add and subtract integers.

SOLAR ENERGY



TEACHER PRESENTATION OUTLINE

SOLAR ENERGY

AGRICULTURAL PRACTICES

Drying of Agricultural & Horticultural Crops
Space Heating of Agricultural Facilities
Production of Biomass as an Energy Source
Production of Ethanol & Methanol

SCIENCE CONCEPTS

Alternative Energy Sources
Solar Energy Space Heating
Solar Energy Hot Water Heating
Photovoltaic Cells
Solar Angles

AGRICULTURAL APPLICATIONS FOR 7&8TH GRADE PHYSICAL SCIENCES:

UNIT TITLES:	ACTIVITIES & APPLICATIONS
Solar Energy	Biomass Energy Sources; pg. 7 Synthetic Fuel Sources; pg. 7 Wind Energy for water pumping; pg. 8 Greenhouse Example; pg. 31 Use of solar heated water; pg.33 Drying of Ag Crops; pg.33 Photovoltaic cells & electric fences; pg.34

TEACHING STEPS
(for teacher to follow)

A. Materials Provided in Teaching Kit:

Black construction paper
thermometers

B. Additional Materials Needed for Student Activities:

2 books or other supports
wristwatch
clear cellophane tape
cardboard box (soda flat)
newspaper
plant material

C. Lesson Outline

D. Teacher's Presentation Outline

E. Audio Visual Materials:

1. Alternative Energy Sources
2. Energy from Biomass
3. Synthetic Fuels
4. Energy from Water
5. Energy from Wind
6. Solar Energy
7. Altitude
8. Trombe Wall
9. Solar Collector
10. Photovoltaic Cells

F. Student Handouts and Quizzes

Student Information Guide
Work Sheet A
Work Sheet B
Work Sheet C
Work Sheet D
Student Activity Note Sheet
Student Activity - 1 Information Sheet
Student Activity - 2 Information Sheet
Student Activity Record Sheet
Quiz 1

LESSON OUTLINE:

Day 1:

Discussion of Attention Step/Problem Statement.
Explanation of General Information about Alternative Energy Sources.
Explanation of Solar Energy.
Explanation of the Angle of the Sun.
Assignment of Student Information Guide on Alternative Energy.
Student Completion of Work Sheet A during class.
Explanation of Scientific Terms.
Student Completion of Work Sheet B during class or as homework.
Individual Study using Computer Study Guide.

Day 2:

Discussion of Scientific Terms Work Sheet (Work Sheet B).
Demonstration of Comparing solar angles to maximize solar energy.
Student Activity of Comparing solar angles to maximize energy.
Assignment of Student Activity - 1 Record Sheet.
Discussion of Student Activity - 1 Record Sheet.
Individual Study using Computer Study Guide.

Day 3:

Explanation of Using Solar Energy as A Heat Source.
Explanation of Solar Hot Water Heating.
Generating Electricity with Solar Energy.
Student Completion of Work Sheet C during class.
Individual Evaluation using Computer Study Guide.

Day 4:

Demonstration of Activity of Drying Horticultural/Agricultural Products.
Student Activity of Drying Horticultural/Agricultural Products.
Individual Evaluation using Computer Quiz.

Day 5:

Review of information on alternative energy sources, solar energy, angle of the sun, using solar energy as a heat source, solar water heating, and generating electricity with solar energy.
Student Completion of Work Sheet D during class.
Individual Evaluation using Computer Quiz.
Student Completion of Quiz 1.

SOLAR ENERGY - AN ALTERNATIVE ENERGY SOURCE

TEACHER'S PRESENTATION OUTLINE

DAY 1

Teaching Note: *Discuss the Attention Step/Problem Statement with the class.*

ATTENTION STEP/PROBLEM STATEMENT

Have students brainstorm about how we use solar energy in our lives and share their thoughts with the class. Encourage students to think about how our way of life depends on the sun. Have students complete the following sentence, " We depend on the sun,_____." Responses will vary, but may include some of the following:

We depend on the sun _____.

1. To heat homes
2. To heat water
3. To generate electricity
4. To heat greenhouses
5. To dry clothes on the clothes line
6. To dry grain in fields
7. To preserve fruits & vegetables
8. To dry flowers
9. So green plants can carry on photosynthesis and provide us with a source of food
10. To heat air so it is warm enough for plants to grow
11. To receive Vitamin D

OBJECTIVES:

KNOWLEDGE OBJECTIVES:
Students will know:
- the characteristics of 7 alternative energy sources
- the amount of solar radiation reaching the United States
- 3 uses for solar energy
- how season and latitude affect the angle of the sun
- differences between active and passive solar heating systems
- differences between direct and indirect solar gain buildings
- parts of a solar collector
- how photovoltaic cells produce electricity
- uses of photovoltaic cells

PERFORMANCE OBJECTIVES:
Students will:
- read a thermometer
- estimate angle of the sun
- dry flowers or decorative material

SOLAR ENERGY - AN ALTERNATIVE ENERGY SOURCE

Teaching Note: ***Explain the following general information about alternative energy sources to the class.***

GENERAL INFORMATION ABOUT ALTERNATIVE ENERGY SOURCES

- Our lifestyles in today's world depend on fossil fuels: oil, natural gas and coal, in addition to nuclear energy to produce electricity, manufacture and transport products, and heat our homes. If we continue using fossil fuels in the manner we have grown accustomed, they will eventually be depleted. Our modern lifestyles require a great deal of energy. Even with conservation measures, alternative sources will still need to be utilized.

Lecture Note: Use overhead # 1 (ALTERNATIVE ENERGY SOURCES)

- Some of the more popular alternative energy forms include: Geothermal, Tidal energy, Biomass, Synthetic Fuels, Water, Wind, and Solar Energy. Most of these energy sources do depend on the sun as an energy source.

- Geothermal energy and tidal energy do not depend on the sun as an energy source. Geothermal energy is a natural energy source from the earth's molten core. In some areas of known geothermal activity, wells have been drilled to tap the energy. The energy comes to the earth's surface as water and steam and can turn the turbines for electric generators.Tidal energy is caused by the gravitational pull and the movement of the earth and moon. Tidal energy can be tapped by trapping water behind a dam when the tide comes in or out. The water is then released gradually and used to turn electric generators.

ALTERNATIVE ENERGY SOURCES THAT DEPEND ON THE SUN

- Most of us do not thingk of energy from biomass, synthetic fuels, water and wind as solar energy, but all these energy sources depend on the sun as an energy source. Without the sun, these energy sources would not exist. By using energy from biomass, synthetic fuels, water, and wind we really are using solar energy and solar energy byproducts.

Lecture Note: Use overhead # 2 (ENERGY FROM BIOMASS)

- Biomass is the remains, waste, or by-products of living things. It is utilized as an energy source by combustion and is the oldest source of energy known. The production of biomass energy is dependent upon solar energy. The sun provides the energy needed for photosynthesis to occur. It is an easily renewable energy source. Biomass resources include wood and other forest materials, grain crops, plant residues such as cobs, husks, and stalks, animal manures, food-processing wastes, and aquatic plants. (Research in biomass presently includes propagating plants which grow quickly (ex. silver maples trees), production of those plants on wide scale acreage, and harvesting of the plants for large scale biomass operations.

Lecture Note: Use overhead # 3 (SYNTHETIC FUELS)

- Synthetic fuels are liquid and gaseous fuels made from non-petroleum sources. Ethanol and methanol are two major types of liquid alcohol. When ethanol is combined with gasoline, it is know as gasohol. Ethanol is obtained from grain crops such as corn. After the grain crop is harvested, it is heated, and the sugars and carbohydrates in the grain are allowed to ferment. Alcohol is then derived from the fermenting grains. Methane can be used as a motor fuel. Methane is a major part of natural gas and can be produced synthetically and used like natural gas. Ethanol, methanol, and methane are renewable energy sources and can be made from wood and forest materials, grains, and agricultural wastes. The prospect of the wide use of ethanol, methane, and methanol is especially attractive to American farmers because they could then produce fuel as well as food.

Lecture Note: Use overhead # 4 (ENERGY FROM WATER)

- Water can be used as an alternative energy source in a couple of ways. The energy from water moving downhill in a stream can be harnessed and used as a source of electric power. The energy can be derived from the water naturally moving downhill, like a waterfall or from man-made dams. Water can also be used as a solar collector, or solar pond in warm climates of the world that also have naturally large deposits of salt. Heat energy is stored in the salt water at the bottom of the solar pond. The use of water as an alternative energy source is dependent on the sun to provide rain and heat. Water is a renewable source of energy.

Lecture Note: Use overhead # 5 (ENERGY FROM WIND)

- Wind is caused by the sun's uneven heating of the surface of the earth. Windmills are used in various places of the world to harness the energy from the wind. Traditionally in our country, windmills have been used to pump water from wells. Before the wide spread use of electricity throughout the countryside, windmills were used to pump water for human and livestock use. Today windmills are still use to pump water from wells for livestock use, especially in remote areas. Wind is also being used as an alternative energy source by individuals who generate electricity to meet their own needs and sell any surplus power to the electric company. Some electric companies have set up many windmills together as wind farms and are also using wind to generate electrical power. The wind is a renewable energy source.

Lecture Note: Use overhead # 6 (SOLAR ENERGY)

- Solar energy is direct energy from the sun. Radiation from the sun can be used for heating, generating electricity, and drying of agricultural crops. It is a completely renewable energy source.

Teaching Note: ***Explain the following information about solar energy to the class.***

SOLAR ENERGY

- Solar energy, or radiation from the sun is an alternative energy source that has been of great interest to our society. There is more than enough energy from solar radiation reaching the earth for the world's energy needs. In the United States, an average of 177 watts of solar radiation strike each square meter of land. This average amount is considerably smaller than the actual amount of solar radiation reaching the earth under ideal conditions, due to darkness and the sun's angle. The amount of solar energy varies with the time of the day, season, weather, and geographic location. In order for solar energy to be useful to us as a constant energy source it must be collected and stored.

- Solar energy can be used for our primary activities that demand energy. Solar energy can be used for space heating. It can be used to heat homes, barns, livestock confinement systems, farm shops, greenhouses, and many other buildings. Solar energy is also used for hot water heating, for drying of agricultural crops, and for generating electricity.

Teaching Note: ***Explain the following information about the angle of the sun to the class.***

Angle of the Sun

- It is important to know the angle the sun strikes the earth in order to collect solar radiation. The angle of solar radiation varies with season and latitude.

- The earth rotates on an axis that runs through the North and South poles. The earth completes a full 360^0 rotation every 24 hours as it orbits around the sun, giving us our day and night. The sun appears to rise in the east and set in the west.

Lecture Note: ***Use overhead #7 (ALTITUDE OF SUN).***

- The polar axis is tilted at 23.5^0, causing sunlight to strike the earth more directly in the summer than in the winter. This causes the sun to appear higher in the sky in the summer than in the winter.

- At the same time the earth is rotating on its polar axis, it is making an elliptical orbit around the sun. The northern part of the rotating earth tilts away from the sun in the winter and toward the sun in the summer. As a result, the days are longer in the summer than in the winter and the shadows are shorter in the summer than they are in the winter.

- In the Northern hemisphere, the least amount of solar energy is available in the winter and the most is available in the summer. Unfortunately, winter is when heating requirements are the largest and summer is when heating requirements are the smallest.

Teaching Note: ***Assign Work Sheet A and Student Information Guide on Light--Part of the Electromagnetic Spectrum. Students can complete Work Sheet A either individually or in small groups during class time.***

STUDENT INFORMATION GUIDE

SOLAR ENERGY--AN ALTERNATIVE ENERGY SOURCE

Our lifestyles in today's world depend on fossil fuels: oil, natural gas and coal, in addition to nuclear energy to produce electricity, manufacture and transport products, and heat our homes. If we continue using fossil fuels in the manner we have grown accustomed, they will eventually be depleted. Our modern lifestyles require a great deal of energy. Even with conservation measures, alternative sources will still need to be utilized.

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Geothermal energy and tidal energy do not depend on the sun as an energy source. Geothermal energy is a natural energy source from the earth's molten core. In some areas of known geothermal activity, wells have been drilled to tap the energy. The energy comes to the earth's surface as water and steam and can turn the turbines for electric generators.Tidal energy is caused by the gravitational pull and the movement of the earth and moon. Tidal energy can be tapped by trapping water behind a dam when the tide comes in or out. The water is then released gradually and used to turn electric generators.

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Synthetic fuels are liquid and gaseous fuels made from non-petroleum sources. Ethanol and methanol are two major types of liquid alcohol. When ethanol is combined with gasoline, it is know as gasohol. Ethanol is obtained from grain crops such as corn. After the grain crop is harvested, it is heated, and the sugars and carbohydrates in the grain are allowed to ferment. Alcohol is then derived from the fermenting grains. Methane can be used as a motor fuel. Methane is a major part of natural gas and can be produced synthetically and used like natural gas. Ethanol, methanol, and methane are renewable energy sources and can be made from wood and forest materials, grains, and agricultural wastes. The prospect of the wide use of ethanol, methane, and methanol is especially attractive to American farmers because they could then produce fuel as well as food.

Water can be used as an alternative energy source in a couple of ways. The energy from water moving downhill in a stream can be harnessed and used as a source of electric power. The energy can be derived from the water naturally moving downhill, like a waterfall or from man-made dams. Water can also be used as a solar collector, or solar pond in warm climates of the world that also have naturally large deposits of salt. Heat energy is stored in the salt water at the bottom of the solar pond. The use of water as an alternative energy source is dependent on the sun to provide rain and heat. Water is a renewable source of energy.

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SOLAR ENERGY

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Solar energy can be used for our primary activities that demand energy. Solar energy can be used for space heating. It can be used to heat homes, barns, livestock confinement systems, farm shops, greenhouses, and many other buildings. Solar energy is also used for hot water heating, for drying of agricultural crops, and for generating electricity.

Angle of the Sun

It is important to know the angle the sun strikes the earth in order to collect solar radiation. The angle of solar radiation varies with season and latitude.

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In the Northern hemisphere, the least amount of solar energy is available in the winter and the most is available in the summer. Unfortunately, winter is when heating requirements are the largest and summer is when heating requirements are the smallest.

Using Solar Energy as a Heat Source for Heating Space
Two basic methods can be employed when using solar energy for space heating of a building. Passive solar energy is a method which uses no mechanical pumps or motors to circulate heat. Active solar energy does require a fan or pump to circulate heated air or water within the building. A disadvantage of using solar heat as a heat source is that buildings must be designed for solar heating when they were built or in an extensive remodeling job.

PASSIVE SOLAR HEATING SYSTEM
In a passive solar heating system, buildings are designed to either let the sun in or keep it out. Orientation of a building (the direction it faces) is very important in the design of a building that is to be heated by solar energy. Solar energy enters a building through windows on the building's south side. The solar energy is converted into thermal energy and is circulated through the buildings using natural heat transfer methods of conduction, convection, and radiation.
A greenhouse is a good example of how solar energy enters a building through windows. A greenhouse uses transparent coverings such as glass, polyethylene, acrylic, and fiberglass for the major portions of its roof and walls. Solar energy enters the greenhouse primarily through its east, south, and west sides & the roof. The primary purpose of most greenhouses is to use the light energy that is transmitted through the roof and walls for the growing of plants. However by trapping light energy, greenhouses also trap a large amount of heat energy in all four seasons of the year. This is a real asset in the winter when it is cold outside and a real problem in the summer, when it can already by too hot for good plant growth. If a greenhouse is to be heated by solar energy alone, it needs a system to store the solar energy for future use just like any other building. Often times, water in black containers, walkways and floors are used to store heat energy. Because of a greenhouse's tremendous ability to trap energy, greenhouse-like structures are being used to provide a warm water environment in some aquaculture operations.

Windows can be covered with insulated coverings at night to reduce heat loss. Greenhouses often use thermal blankets or thermal curtains at night to cover a large area of benches where plants are grown to prevent heat loss. Roof overhangs screen unwanted sunlight in the summer and still allow the entry of sun in the winter.

Solar buildings can either be described as a direct or indirect gain solar building. In a direct (thermal) gain solar building, a part of the interior structure absorbs the solar radiation and stores it. Concrete, brick, or stone are good storage materials that can be incorporated into floors, a wall, or chimney.

In an indirect gain solar building, the energy absorbing materials are not part of the normal living or production area. The heat-storage materials are generally placed in a structure between south facing windows and the area that is being heated. Heat-storage materials include water in black containers, brick, or concrete. The solar energy absorbed by the storage structure is radiated into the living space by convection. A Trombe wall is one popular indirect gain system. Another popular indirect gain system uses an attached greenhouse on the south side of a building.

ACTIVE SOLAR HEATING SYSTEM

In an active solar heating system, solar energy is collected and stored in an area away from the area where it will be used. Pumps or fans are used to circulate heated water or air to the area where heat is needed. An active solar heating system can be used as a primary or secondary source of heat for homes, livestock confinement operations, and other agricultural buildings. Solar collectors are usually used to collect solar energy in an active solar heating system.

Solar collectors are generally shaped like a flat box. They are placed at an angle on the roof or on the ground to collect solar energy. Usually they are placed facing south, at an angle that equals geographic latitude plus 15^0. In Southern Illinois for example, collectors would be 37^0 (for 37^0 N) + 15^0 = 52^0.

Sunlight enters the solar collector through a transparent cover plate. A black metallic absorber plate is heated by entering sunlight. Circulating water or air is used to remove the thermal energy from the absorber plate. The thermal energy is then transferred to a storage area or to the area where heat is needed by pumps or fans.

Solar Hot Water Heating

Solar hot water heating can be adapted by most conventional homeowners, even those who cannot easily utilize solar space heating because their existing homes were not designed for it. It can also be used in many businesses. Some examples of businesses that use solar heated water are: agricultural processing plants, greenhouses during the winter, and aquaculture operations.

When water is heated by solar energy, a system using solar collectors similar to the ones used in an active solar space heating system are used. Water can be heated in the solar collector and then returned to a storage tank until it is ready to be used.

Drying Agricultural Crops with Solar Energy

The use of solar energy to dry agricultural crops dates back in history to the beginning of farming. Many crops need to be dried in order to prevent spoilage during storage. Grain crops such as corn, beans, wheat, and oats have long been dried in the field by solar energy and then

harvested when the crops were at or near the correct moisture level. Solar grain dryers can be used to dry the grain crops after they are harvested.

Hay is a good example of a crop that depends on solar energy for drying. When hay is harvested, the grass or legume, such as tall fescue, clover, or alfalfa, are mowed and allowed to dry on the ground on the field. The weather has a direct affect on the time it takes for the hay to dry. During hot, windy, sunny days, the hay can be at the correct moisture level for storage ia one day, while during damp, humid, cloudy days it may take several days to dry the hay. Sometimes a hay rake is used to turn the hay over on the ground to speed up the drying time. After the hay has dried to the correct moisture level, it can be harvested and stored.

Other crops are dried to prolong their use, such as some of the floricultural crops which are dried and then used in dried flower arrangements. Still, other agricultural crops are preserved by drying during processing. Fruits, vegetables, and nuts may be dried to preserve them and then packaged into a number of packaged trail mixes and dehydrated mixtures.

Generating Electricity with Solar Energy

One method of generating electricity with solar energy is by the use of photovoltaic cells, or solar cells. Some materials release electrons when light shines on them. Materials that have this property include selenium, silicon, germanium, and cadmium sulfide. Cells made of these materials are called photovoltaic cells.

Photovoltaic cells consist of a layer of semiconductor such as silicon. The front of the silicon is coated with a thin, transparent conducting film. The back of the silicon is coated with a thicker conducting aluminum layer. When sunlight strikes a photovoltaic cell, electrons flow between the two conducting layers and creates an electrical current. The current can be stored in a battery.

Photovoltaic cells are small and are about as thick as a dime. They produce only a small amount of electricity. They can be linked together to create a larger amount of electricity.

Photovoltaic cells are currently being used as an energy source for everyday items such as calculators, wristwatches, and exposure meters in cameras. They can generate enough energy to power electrical fence chargers for electric fences. Electric fences have an electrical current running through them and are used to fence in livestock. Photovoltaic cells are also used in orbiting satellites and spacecrafts to partially fulfill their energy needs.

GLOSSARY OF SCIENTIFIC TERMS:

active solar heating system - uses pumps to remove thermal energy from a solar collector and uses pumps to circulate heat within the building

conduction - type of heat transfer in which heat moves through a material without the material itself moving

convection - type of heat transfer in which heat moves through a material by actual movement of the material

direct gain solar building - building in which the interior structure absorbing the solar radiation is part of the living area (ex. wall, chimney, fireplace)

indirect gain solar building - building in which the energy-absorbing unit is not part of the living area, but a structure between the south-facing windows and the living area

passive solar heating system - solar heating system which uses no mechanical pumps for circulating heat

photovoltaic cells - solar cell

radiation - pure energy that moves through space

semiconductor - a substance used as in transistors to control electron flow

solar cell - device that releases electrons which creates an electrical current and produces electrical energy, when the sun strikes it.

solar collector -	devise used to collect solar energy (ex. flat-plate collector, water)
solar energy -	radiation from the sun
solar pond -	pond containing heavily salted water from which heat does not escape
thermal energy -	heat energy
Trombe wall -	wall that is 8 - 18 inches thick and is placed 4 inches from a south-facing double thickness glass window

WORK SHEET A

DIRECTIONS: Complete the following questions.

1. Sources of energy other than fossil fuels are known as _alternative energy sources_.

2. The alternative energy systems of Biomass, Synthetic Fuels, Water, Wind, and Solar Energy are all dependent on the _sun._

3. _Geothermal energy_ is a natural energy source from the earth's molten core that comes to the earth's surface as water and steam.

4. _Tidal energy_ can be tapped by trapping water behind a dam when the tide comes in or out and then used to turn electric generators.

5. _Biomass_ is the remains, waste, or by-products of living things and is utilized as an energy source by combustion.

6. Biomass energy is dependent upon solar energy because the sun provides the energy needed for _photosynthesis_ to occur in plants.

7. Biomass resources are easily _renewable_.

8. _Synthetic fuels_ are liquid and gaseous fuels made from non-petroleum sources.

9. Ethanol and methanol are two major types of _liquid alcohol_.

10. Ethanol, methanol, and methane are _renewable_ energy sources and can be made from wood and forest materials, grains, and agricultural wastes.

11. The energy from water moving downhill in a stream can be harnessed and used as a source of _electric power_.

12. _Water_ can also be used as a solar collector, or solar pond to store heat energy.

13. The use of water as an alternative energy source is dependent on the sun to provide *rain* and *heat*.

14. *Wind* is being used as an alternative energy source by individuals who generate electricity to meet their own needs and sell any surplus power to the electric company.

15. *Solar energy* is direct energy from the sun.

16. In the United States, an average of *177* watts of solar radiation strike each square meter of land.

17. The amount of *solar energy* available for people to use varies with the time of the day, season, weather, and geographic location.

18. In order for solar energy to be useful to us as a constant energy source it must be *collected* and *stored*.

19. The angle of *solar radiation* varies with season and latitude.

20. In the *Northern hemisphere*, the least amount of solar energy is available in the winter and the most is available in the summer.

Teaching Note: ***Explain the following terms to the class and then assign Work Sheet B. The Students can find the definitions for these terms in the Student Information Guide. Students can complete Work sheet B during class or as homework.***

GLOSSARY OF SCIENTIFIC TERMS:

active solar heating system -	uses pumps to remove thermal energy from a solar collector and uses pumps to circulate heat within the building
conduction -	type of heat transfer in which heat moves through a material without the material itself moving
convection -	type of heat transfer in which heat moves through a material by actual movement of the material
direct gain solar building -	building in which the interior structure absorbing the solar radiation is part of the living area (ex. wall, chimney, fireplace)
indirect gain solar building -	building in which the energy-absorbing unit is not part of the living area, but a structure between the south-facing windows and the living area
passive solar heating system -	solar heating system which uses no mechanical pumps for circulating heat
photovoltaic cells -	solar cell
radiation -	pure energy that moves through space
semiconductor -	a substance used as in transistors to control electron flow

solar cell -	device that releases electrons which creates an electrical current and produces electrical energy, when the sun strikes it.
solar collector -	devise used to collect solar energy (ex. flat-plate collector, water)
solar energy -	radiation from the sun
solar pond -	pond containing heavily salted water from which heat does not escape
thermal energy -	heat energy
Trombe wall -	wall that is 8 - 18 inches thick and is placed 4 inches from a south-facing double thickness glass window

WORK SHEET B

Directions: The answers to the following fill-in-the blank questions are terms which have something to do with solar energy. Choose the term from the word list below that best answers each question. Each term may be used only once.

Word List:

active solar heating system
conduction
convection
direct gain solar building
indirect gain solar building
passive solar heating system
photovoltaic cells
radiation
semiconductor
solar cell
solar conductor
solar energy
solar pond
thermal energy
trombe wall

Fill-in-the blank:

1. A *solar cell* is a device that releases electrons to produce electrical energy when the sun strikes it.

2. *Conduction* is a type of heat transfer in which heat moves through a material without the material itself moving.

3. *Solar energy* is radiation from the sun.

4. Another term for solar cells is *photovoltaic cells*.

5. Pure energy that moves through space is called *radiation*.

6. An *active solar heating system* uses pumps to remove thermal energy from a solar collector and uses pumps to circulate heat within the building.

7. A type of heat transfer in which heat moves through a material by actual movement of the material is called *convection*.

8. A *direct gain solar building* has an interior structure absorbing the solar radiation as part of the living area.

9. A devise used to collect solar energy is known as a *solar collector* .

10. *Indirect gain solar buildings* contain an energy-absorbing unit that is not part of the living area, but a structure between the south-facing windows and the living area.

11. A *Trombe wall* is 8 - 18 inches thick and is placed 4 inches from a south-facing double thickness glass window.

12. Another name for *thermal energy* is heat energy.

13. A *solar pond* contains heavily salted water from which heat does not escape.

14. *Passive solar heating systems* do not use mechanical pumps for circulating heat.

15. A substance used to control electron flow is called a *semiconductor* .

Teaching Note: ***The students may use the Solar Energy-- An alternative Energy Source Study Guide Computer Program for individual study and review for this lesson.***

Day 2:

Teaching Note: ***Demonstrate Comparing solar angles to maximize solar energy activity. Students can take notes and record them on the Student Activity Sheet during the teacher demonstration. The steps and procedures are found in the Student Activity - 1 Information Sheet, "Comparing Solar Angles to Maximize Solar Energy". The activity and demonstration steps are summarized below.***

Activity Summary: ***This activity should be done on a sunny day. Students can work in groups of 2 - 5 students. Show students where to conduct the activity. Demonstrate how to make a pocket out of construction paper. Demonstrate how to read a thermometer and how to shake the temperature down. Show students how to books can be used to prop up the thermometer in a pocket in different positions including pocket laying flat on a book, pocket standing straight up, and pocket positioned so sun is shining inside it.***

Teaching Note: ***Assign and discuss Student Activity - 1 Information Sheet, "Comparing Solar Angles To Maximize Solar Energy". Provide the students with supplies for the student activity and answer any questions. Coordinate the Student Activity.***

STUDENT ACTIVITY NOTE SHEET

List steps to follow:

1. Location of activity

2. Making a construction paper pocket

3. Reading a thermometer and shaking the temperature down

4. Positioning the pocket at different angles

STUDENT ACTIVITY - 1
INFORMATION SHEET

Comparing solar angles to maximize solar energy

a. **Purpose:** To determine how the angle that sunlight strikes an object effects the energy absorbed by that object. For example, it is important to know at what angle solar collectors should be placed, in order to collect maximum solar radiation.

b. **What Each Group of Students Needs:**

1 sheet of black construction paper
clear cellophane tape
thermometer
2 books or other supports
wristwatch

c. **Here's How:**

1. Work in your assigned group.

2. Get a sheet of black construction paper. You will be using it to make a pocket for your thermometer.

3. Fold the paper in half. Now, make 1/2 inch fold on the two sides of the paper. Tape the sides of the paper together to form the pocket.

4. Place a thermometer inside the pocket. (Put the bulb end of the thermometer in the pocket first.)

5. Put the pocket with the thermometer in a shady place for 5 minutes. After 5 minutes, check the temperature. Record all temperatures during this activity on Part B of the Activity Record Sheet - 1. Then shake down the thermometer and put it back into the paper pocket.

6. Move to a sunny location. Place a book or other flat object on the ground and lay the pocket with the thermometer on top of it. Record the temperature on the Activity Record Sheet - 1 after 5 minutes. Then shake down the thermometer and put it back into the paper pocket.

7. Use your books or other supports to position the pocket with the thermometer so it is standing straight up, perpendicular with the ground. Record the temperature after 5 minutes. Then shake down the thermometer and put it back into the paper pocket.

8. Position the pocket containing the thermometer, so the sun shines directly into the pocket. Record the temperature after 5 minutes.

9. Select a position for the pocket containing the thermometer, that you think will receive the greatest amount of solar radiation. After 5 minutes, record the temperature.

STUDENT ACTIVITY - 1
RECORD SHEET

A. Predictions: *(Answers will vary.)*

1. Which position do you think will receive the must solar energy?

2. Which position do you think will receive the least solar energy?

3. What factors other than the angle of the sun may affect your results?

B. Data: *(Answers will vary.)*

1. Describe the weather conditions at the time this activity was taking place.

2. Describe where the sun is located in the sky during this activity.

3. Record your data from the activity in the table below:

	TIME	ANGLE THAT SUN STRIKES THERMOMETER	TEMPERATURE
A. POCKET IN SHADY AREA			
B. POCKET LAYING FLAT ON BOOK			
C. POCKET STANDING STRAIGHT UP			
D. POCKET POSITIONED SO SUN IS SHINING INSIDE IT			
E. DESCRIBE HOW POCKET IS ANGLED			

C. Conclusions: *(Answers will vary.)*

1. In which of the positions was the sunlight hitting the face of the pocket at the greatest angle?

2. In which of the positions was the sunlight hitting the face of the pocket at the smallest angle?

3. In which position was the highest temperature recorded? Why do you think the temperature was highest in this position?

4. In which position was the lowest temperature recorded? Why do you think the temperature was lowest in this position?

5. How does the angle of the sunlight striking an object affect the amount of solar energy it receives?

Day 3

Teaching Note: ***Discuss the Scientific Terms Work Sheet (Work Sheet B) with the class.***

Teaching Note: ***Explain the following information about Using Solar Energy as a Heat Source to the class.***

Using Solar Energy as a Heat Source for Heating Space

- Two basic methods can be employed when using solar energy for space heating of a building. Passive solar energy is a method which uses no mechanical pumps or motors to circulate heat. Active solar energy does require a fan or pump to circulate heated air or water within the building. A disadvantage of using solar heat as a heat source is that buildings must be designed for solar heating when they were built or in an extensive remodeling job.

PASSIVE SOLAR HEATING SYSTEM

- In a passive solar heating system, buildings are designed to either let the sun in or keep it out. Orientation of a building (the direction it faces) is very important in the design of a building that is to be heated by solar energy. Solar energy enters a building through windows on the building's south side. The solar energy is converted into thermal energy and is circulated through the buildings using natural heat transfer methods of conduction, convection, and radiation.

- A greenhouse is a good example of how solar energy enters a building through windows. A greenhouse uses transparent coverings such as glass, polyethylene, acrylic, and fiberglass for the major portions of its roof and walls. Solar energy enters the greenhouse primarily through its east, south, and west sides & the roof. The primary purpose of most greenhouses is to use the light energy that is transmitted through the roof and walls for the growing of plants. However by trapping light energy, greenhouses also trap a large amount of heat energy in all four seasons of the year. This is a real asset in the winter when it is cold outside and a real problem in the summer, when it can already by too hot for good plant growth. If a greenhouse is to be heated by solar energy alone, it needs a system to store the solar energy for future use just like any other building. Often times, water in black containers, walkways and floors are used to store heat energy. Because of a greenhouse's tremendous ability to trap energy, greenhouse-like structures are being used to provide a warm water environment in some aquaculture operations.

- Windows can be covered with insulated coverings at night to reduce heat loss. Greenhouses often use thermal blankets or thermal curtains at night to cover a large area of benches where plants are grown to prevent heat loss. Roof overhangs screen unwanted sunlight in the summer and still allow the entry of sun in the winter.

- Solar buildings can either be described as a direct or indirect gain solar building. In a direct (thermal) gain solar building, a part of the interior structure absorbs the solar radiation and stores it. Concrete, brick, or stone are good storage materials that can be incorporated into floors, a wall, or chimney.

Lecture Note: ***Use overhead #8 (TROMBE WALL).***

- In an indirect gain solar building, the energy absorbing materials are not part of the normal living or production area. The heat-storage materials are generally placed in a structure between south facing windows and the area that is being heated. Heat-storage materials include water in black containers, brick, or concrete. The solar energy absorbed by the storage structure is radiated into the living space by convection. A Trombe wall is one popular indirect gain system. Another popular indirect gain system uses an attached greenhouse on the south side of a building.

ACTIVE SOLAR HEATING SYSTEM

- In an active solar heating system, solar energy is collected and stored in an area away from the area where it will be used. Pumps or fans are used to circulate heated water or air to the area where heat is needed. An active solar heating system can be used as a primary or secondary source of heat for homes, livestock confinement operations, and other agricultural buildings. Solar collectors are usually used to collect solar energy in an active solar heating system.

Lecture Note: ***Use overhead #9 (SOLAR COLLECTOR).***

- Solar collectors are generally shaped like a flat box. They are placed at an angle on the roof or on the ground to collect solar energy. Usually they are placed facing south, at an angle that equals geographic latitude plus 15^0. In Southern Illinois for example, collectors would be 37^0 (for 37^0 N) + 15^0 = 52^0. Sunlight enters the solar collector through a transparent cover plate. A black metallic absorber plate is heated by entering sunlight. Circulating water or air is used to remove the thermal energy from the absorber plate. The thermal energy is then transferred to a storage area or to the area where heat is needed by pumps or fans.

Teaching Note: ***Explain the following information about solar hot water heating to the class.***

Solar Hot Water Heating

- Solar hot water heating can be adapted by most conventional homeowners, even those who cannot easily utilize solar space heating because their existing homes were not designed for it. It can also be used in many businesses. Some examples of businesses that use solar heated water are: agricultural processing plants, greenhouses during the winter, and aquaculture operations.

- When water is heated by solar energy, a system using solar collectors similar to the ones used in an active solar space heating system are used. Water can be heated in the solar collector and then returned to a storage tank until it is ready to be used.

Teaching Note: ***Explain the following information about Drying Agricultural crops with solar energy to the class.***

Drying Agricultural Crops with Solar Energy

- The use of solar energy to dry agricultural crops dates back in history to the beginning of farming. Many crops need to be dried in order to prevent spoilage during storage. Grain crops such as corn, beans, wheat, and oats have long been dried in the field by solar energy and then harvested when the crops were at or near the correct moisture level. Solar grain dryers can be used to dry the grain crops after they are harvested.

- Hay is a good example of a crop that depends on solar energy for drying. When hay is harvested, the grass or legume, such as tall fescue, clover, or alfalfa, are mowed and allowed to dry on the ground on the field. The weather has a direct affect on the time it takes for the hay to dry. During hot, windy, sunny days, the hay can be at the correct moisture level for storage ia one day, while during damp, humid, cloudy days it may take several days to dry the hay. Sometimes a hay rake is used to turn the hay over on the ground to speed up the drying time. After the hay has dried to the correct moisture level, it can be harvested and stored.

- Other crops are dried to prolong their use, such as some of the floricultural crops which are dried and then used in dried flower arrangements. Still, other agricultural crops are preserved by drying during processing. Fruits, vegetables, and nuts may be dried to preserve them and then packaged into a number of packaged trail mixes and dehydrated mixtures.

Teaching Note: ***Explain the following information about generating electricity with solar energy to the class.***

Generating Electricity with Solar Energy

- One method of generating electricity with solar energy is by the use of photovoltaic cells, or solar cells. Some materials release electrons when light shines on them. Materials that have this property include selenium, silicon, germanium, and cadmium sulfide. Cells made of these materials are called photovoltaic cells.

Lecture Note: ***Use overhead #10 (PHOTOVOLTAIC CELL).***

- Photovoltaic cells consist of a layer of semiconductor such as silicon. The front of the silicon is coated with a thin, transparent conducting film. The back of the silicon is coated with a thicker conducting aluminum layer. When sunlight strikes a photovoltaic cell, electrons flow between the two conducting layers and creates an electrical current. The current can be stored in a battery.

- Photovoltaic cells are small and are about as thick as a dime. They produce only a small amount of electricity. They can be linked together to create a larger amount of electricity.

- Photovoltaic cells are currently being used as an energy source for everyday items such as calculators, wristwatches, and exposure meters in cameras. They can generate enough energy to power electrical fence chargers for electric fences. Electric fences have an electrical current running through them and are used to fence in livestock. Photovoltaic cells are also used in orbiting satellites and spacecrafts to partially fulfill their energy needs.

WORK SHEET C

DIRECTIONS: Complete the following questions.

1. *Passive solar energy* is a method which uses no mechanical pumps or motors to circulate heat.

2. *Active solar energy* does require a fan or pump to circulate heated air or water within the building.

3. In Solar energy heating systems, solar energy enters a building through windows on the building's *south* side. The solar energy is converted into *thermal energy* and is circulated through the buildings.

4. *Concrete, brick,* or *stone* are good thermal heat storage materials that can be incorporated into floors, a wall, or chimney of a building.

5. In an indirect gain system, solar energy absorbed by the storage structure is radiated into the living space by *convection.*

6. *Solar collectors* are usually used to collect solar energy in an active solar heating system.

7. The *thermal energy* from the solar collectors is then transferred to a storage area or living area by pumps or fans.

9. Solar *hot water* heating can be adapted by most conventional homeowners.

10. When water is heated by solar energy, a system using solar *collectors* similar to the ones used in an active solar space heating system are used.

11. One method of generating electricity with solar energy is by the use of *photovoltaic cells*, or solar cells.

12. Photovoltaic cells consist of a layer of semiconductor such as *silicon*.

13. When sunlight strikes a photovoltaic cell, *electrons* flow between the two conducting layers and creates an electrical current.

Teaching Note: ***The students may use the Solar Energy--An Alternative Energy Source Study Guide Computer Program for individual study and review for this lesson.***

Day 4

Teaching Note: ***Demonstrate Drying Horticultural/Agricultural Products Activity. The steps and procedures are found in Student Activity - 2 Information Sheet, "Drying Horticultural/Agricultural Products". The activity and demonstration steps are summarized below.***

Activity Summary: ***The activity should be done on a sunny day. Student groups may choose the activity they with to do. Students should be given the chance to choose the activity they wish to do several days in advance so they can have materials ready. Different horticultural products may be dried either on flat on cardboard or between newspaper.***

Teaching Note: ***Provide the students with supplies for the student activity and answer andy questions. Coordinate the Student Activity.***

STUDENT ACTIVITY - 2
INFORMATION SHEET

DRYING HORTICULTURAL/AGRICULTURAL PRODUCTS

a. **Introduction:** Solar energy has long been used as an energy source for the drying of grains, vegetables, flowers and foliage, bulbs, and other agricultural crops. Some of the drying occurs naturally near harvest time when the crop is still in the field. In other cases, crops or seeds are harvested and placed in the sun to dry. There has also been a renewed interest in preserving food by using solar energy.

b. **Purpose:** To demonstrate how solar energy can be used as an energy source for drying horticultural products

c. **What Each Group of Students Needs:**
cardboard box similar to soda flat box
newspaper
plant material

d. **Here's How:**

1. Work in your assigned group.

2. Select the horticultural product you wish to try to dry. All horticultural products should be in good condition and approaching maturity. Some possibilities include:
   a. apple slices to be used on wreathes or decorations
   b. pumpkins, gourds or other fall fruit decorations
   c. flowers for pressing, especially thin flowers such as pansies, violets, & wildflowers
   d. foliage
   e. flowers that will maintain their shape such as roses, and strawflowers
   f. wild flowers gathered by the roadside
   g. bulbs

3. Prop your soda flat box up in a sunny spot. Place your box so the sun's rays will be shining into the box for most of the day. (Use information obtained in Activity 1.)

4. If materials are to be pressed, place between newspaper and weight with cardboard or heavy books.

5. Return the boxes with the plant material to the classroom over night. Return the boxes to the sun every day until plant products are dry, usually 3 - 7 days.

6. Examine your end result. Did solar energy dry the products? How would you change the drying schedule if you were to repeat the activity.

STUDENT ACTIVITY - 2
INFORMATION SHEET

DRYING HORTICULTURAL/AGRICULTURAL PRODUCTS

a. **Introduction:** Solar energy has long been used as an energy source for the drying of grains, vegetables, flowers and foliage, bulbs, and other agricultural crops. Some of the drying occurs naturally near harvest time when the crop is still in the field. In other cases, crops or seeds are harvested and placed in the sun to dry. There has also been a renewed interest in preserving food by using solar energy.

b. **Purpose:** To demonstrate how solar energy can be used as an energy source for drying horticultural products

c. **What Each Group of Students Needs:**
cardboard box similar to soda flat box
newspaper
plant material

d. **Here's How:**

1. Work in your assigned group.

2. Select the horticultural product you wish to try to dry. All horticultural products should be in good condition and approaching maturity. Some possibilities include:
   a. apple slices to be used on wreathes or decorations
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4. If materials are to be pressed, place between newspaper and weight with cardboard or heavy books.

5. Return the boxes with the plant material to the classroom over night. Return the boxes to the sun every day until plant products are dry, usually 3 - 7 days.

6. Examine your end result. Did solar energy dry the products? How would you change the drying schedule if you were to repeat the activity.

Teaching Note: ***Review information about Solar Energy with students. Some key facts are listed below:***

Teacher Review:

- Some of the more popular alternative energy forms include: Geothermal, Tidal energy, Biomass, Synthetic Fuels, Water, Wind, and Solar Energy. All of these energy sources depend on the sun, with the exception of Geothermal and Tidal energy.

- Geothermal energy is a natural energy source from the earth's molten core. Tidal energy is caused by the gravitational pull and the movement of the earth and moon. Tidal energy can be tapped by trapping water behind a dam when the tide comes in or out. Biomass is the remains, waste, or by-products of living things. It is utilized as an energy source by the combustion and is the oldest source of energy know. Synthetic fuels are liquid and gaseous fuels made from non-petroleum sources. Ethanol and methanol are two major types of liquid alcohol. The energy from water moving downhill in a stream can be harnessed and used as a source of electric power. Wind is caused by the sun's uneven heating of the surface of the earth. Windmills are used in various places of the world to harness the energy from the wind and generate electrical power. Solar energy is direct energy from the sun.

- Solar energy, or radiation from the sun is an alternative energy source that has been of great interest to our society. There is more than enough energy from solar radiation reaching the earth for the world's energy needs. In the United States, an average of 177 watts of solar radiation strike each square meter of land. This average amount is considerably smaller than the actual amount of solar radiation reaching the earth under ideal conditions, due to darkness and the sun's angle. The amount of solar energy varies with the time of the day, season, weather, and geographic location. In order for solar energy to be useful to us as a constant energy source it must be collected and stored.

- It is important to know the angle the sun strikes the earth in order to collect solar radiation. The angle of solar radiation varies with season and latitude.

- In the Northern hemisphere, the least amount of solar energy is available in the winter and the most is available in the summer. Unfortunately, winter is when heating requirements are the largest and summer is when heating requirements are the smallest.

- Two basic methods can be employed when using solar energy for space heating of a building. Passive solar energy is a method which uses no mechanical pumps or motors to circulate heat. Active solar energy does require a fan or pump to circulate heated air or water within the building.

- In a passive solar heating system, buildings are designed to either let the sun in or keep it out. Solar energy enters a building through windows on the building's south side. Windows can be covered with insulated coverings at night to reduce heat loss.

- In a direct (thermal) gain solar building, a part of the interior structure absorbs the solar radiation and stores it. Concrete, brick, or stone are good storage materials that can be incorporated into floors, a wall, or chimney.

- In an indirect gain solar building, the energy absorbing materials are not part of the normal living area. The heat-storage materials are placed in a structure between south facing windows and the living area. Heat-storage materials include water in black containers, brick, or concrete.

- In an active solar heating system, solar energy is collected and stored in an area away from the living area. Pumps or fans are used to circulate heated water or air to the living area. Solar collectors are usually used to collect solar energy in an active solar heating system.

- Solar collectors are generally shaped like a flat box. They are placed at an angle on the roof or on the ground to collect solar energy. Sunlight enters the solar collector through a transparent cover plate. A black metallic absorber plate is heated by entering sunlight. Circulating water or air is used to remove the thermal energy from the absorber plate. The thermal energy is then transferred to a storage area or living area by pumps or fans.

- Solar hot water heating can be adapted by most conventional homeowners, even those who cannot easily utilize solar space heating because their existing house was not designed for it.

- When water is heated by solar energy, a system using solar collectors similar to the ones used in an active solar space heating system are used. Water can be heated in the solar collector and then returned to a storage tank until it is ready to be used.

- One method of generating electricity with solar energy is by the use of photovoltaic cells, or solar cells. Some materials release electrons when light shines on them. Materials that have this property include selenium, silicon, germanium, and cadmium sulfide. Cells made of these materials are called photovoltaic cells.

- Photovoltaic cells consist of a layer of semiconductor such as silicon. The front on the silicon is coated with a thin, transparent conducting film. The back of the silicon is coated with a thicker conducting aluminum layer. When sunlight strikes a photovoltaic cell, electrons flow between the two conducting layers and creates an electrical current. The current can be stored in a battery.

- Photovoltaic cells are small and are about as thick as a dime. They produce only a small amount of electricity. They can be linked together to create a larger amount of electricity.

- Photovoltaic cells are currently being used as an energy source for calculators, wristwatches, and exposure meters in cameras. They are also used in orbiting satellites and spacecrafts to partially fulfill their energy needs.

Teaching Note: ***The students may use the Solar Energy--An Alternative Energy Source Computer Quiz for individual evaluation.***

Day 5:

Teaching Note: ***Students should complete Work Sheet D: Student Review during class time.***

WORK SHEET D: STUDENT REVIEW

1. Name and describe 5 alternative energy forms.

Some of the more popular alternative energy forms include: Geothermal, Tidal energy, Biomass, Synthetic Fuels, Water, Wind, and Solar Energy.

a. *Geothermal energy is a natural energy source from the earth's molten core.*
b. *Tidal energy can be tapped by trapping water behind a dam when the tide comes in or out.*
c. *Biomass is utilized as an energy source by the combustion.*
d. *Synthetic fuels are liquid and gaseous fuels made from non-petroleum sources, such as agricultural wastes.*
e. *Hydroelectric power is gotten by harnessing the energy from water moving downhill in a stream.*
f. *Windmills harness the energy from the wind and generate electrical power.*
g. *Solar energy is direct energy from the sun and can be used as a heat source and to generate electricity.*

2. When is the most solar energy available in the Northern hemisphere?

In the Northern hemisphere, the most solar energy is available in the summer.

3. What is the difference between passive solar energy and active solar energy?

Passive solar energy is a method which uses no mechanical pumps or motors to circulate heat. Active solar energy does require a fan or pump to circulate heated air or water within the building.

4. What is the difference between a direct (thermal) gain solar building and indirect gain solar building?

In a direct (thermal) gain solar building, a part of the interior structure in the living area absorbs the solar radiation and stores it. In an indirect gain solar building, the energy absorbing materials are not part of the normal living area. The heat-storage materials are placed in a structure between south facing windows and the living area.

5. How is water heated in a solar hot water heating system?

Solar collectors are used to heat the water. The solar collectors are generally shaped like a flat box. They are placed at an angle on the roof or on the ground to collect solar energy. Sunlight enters the solar collector through a transparent cover plate. A black metallic absorber plate is heated by entering sunlight. Circulating water is used to remove the thermal energy from the absorber plate. The thermal energy is then transferred to a storage tank until it is ready to be used.

6. What are photovoltaic cells?

Photovoltaic cells, or solar cells, generate electricity by using solar energy. They are small, about the size of a dime, and generate electricity when sunlight strikes them.

7. Name 3 items that use photovoltaic cells as an energy source.
Calculators
Wristwatches
Exposure meters in cameras

Teaching Note: ***The students may use the Solar Energy--An Alternative Energy Source Computer Quiz for individual evaluation.***

Teaching Note: ***Quiz 1 can be used to evaluate student's knowledge of Solar Energy--An Alternative Energy Source.***

QUIZ 1

A: MATCHING:

__c__1. Solar Energy

__d__2. Passive Solar Heating System

__b__3. Active Solar Heating System

__a__4. Direct Gain Solar Building

__e__5. Indirect Gain Solar Building

a. has interior structure absorbing solar radiation as part of the living area
b. uses mechanical pumps to circulate heat
c. radiation from the sun
d. does not use mechanical pumps to circulate heat
e. has an energy-absorbing unit located between the south-facing windows & living area, but is not an actual part of the living area

B: TRUE OR FALSE:

__F__6. Energy from fossil fuels is known as alternative energy sources.

__T__7. Biomass is a renewable energy source.

__F__8. Ethanol, methanol, and methane are examples or non-renewable energy sources.

__T__9. The angle of solar radiation varies with the season and latitude.

__T__10. The amount of solar energy available for people to use varies with the time of day, season, weather, and geographic location.

C: FILL-IN-THE BLANK:

11. *Synthetic fuels* such as ethanol, methanol, and methane are made from wood, grains, and agricultural wastes.

12. *Biomass* is the remains, waste, or by-products of living things and is utilized as an energy source by combustion.

13. *Solar* energy is energy direct from the sun

14. The angle of *solar radiation* varies with season and latitude.

15. A *solar collector* is a devise that is used to collect solar energy.

D: SHORT ANSWER:

16. Wy is it important to know the angle of solar radiation in the winter?

Winter is when solar heating is needed most. By knowing the angle of solar radiation, solar collectors can be placed so they collect as much solar energy as possible.

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E: AUDIO VISUAL MATERIALS:

1. Alternative Energy Sources
2. Energy from Biomass
3. Synthetic Fuels
4. Energy from Water
5. Energy from Wind
6. Solar Energy
7. Altitude
8. Trombe Wall
9. Solar Collector
10. Photovoltaic Cells

OH1

ALTERNATIVE ENERGY SOURCES

1. GEOTHERMAL
2. TIDAL
3. BIOMASS
4. SYNTHETIC FUELS
5. WATER
6. WIND
7. SOLAR

OH2

ENERGY FROM BIOMASS

1. UTILIZED BY COMBUSTION

2. DEPENDENT ON SOLAR ENERGY

3. EASILY RENEWABLE

4. SOURCES INCLUDE:
   WOOD
   GRAIN CROPS
   PLANT RESIDUES
   ANIMAL MANURES
   FOOD-PROCESSING WASTES
   AQUATIC PLANTS

OH3

SYNTHETIC FUELS

1. LIQUID
   ETHANOL & METHANOL

2. GASEOUS
   METHANE

3. DEPENDENT ON SOLAR
   ENERGY

4. RENEWABLE

4. SOURCES:
   WOOD
   GRAINS
   AGRICULTURAL WASTES

OH4

ENERGY FROM WATER

1. HYDROELECTRIC POWER

2. SOLAR PONDS

3. DEPENDENT ON SOLAR ENERGY

4. RENEWABLE

OH5

ENERGY FROM THE WIND

1. DEPENDENT ON SOLAR ENERGY

2. WINDMILLS HARNESS POW ER

3. RENEWABLE

OH6

SOLAR ENERGY

1. ENERGY DIRECTLY FROM THE SUN

2. ENERGY SOURCE FOR HEATING

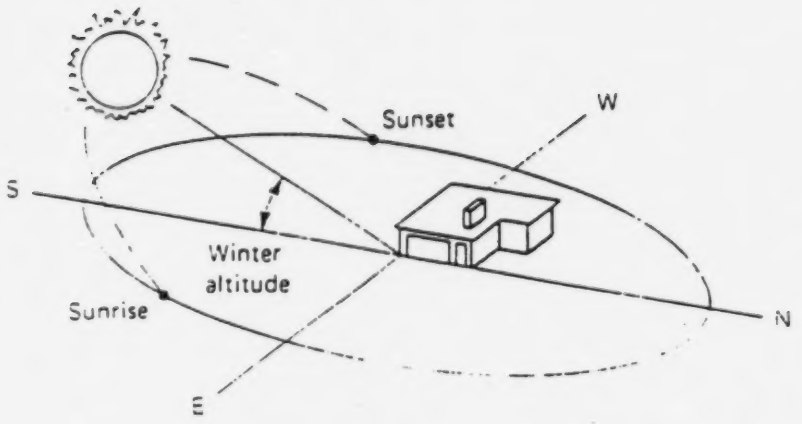
3. ENERGY SOURCE FOR ELECTRICITY

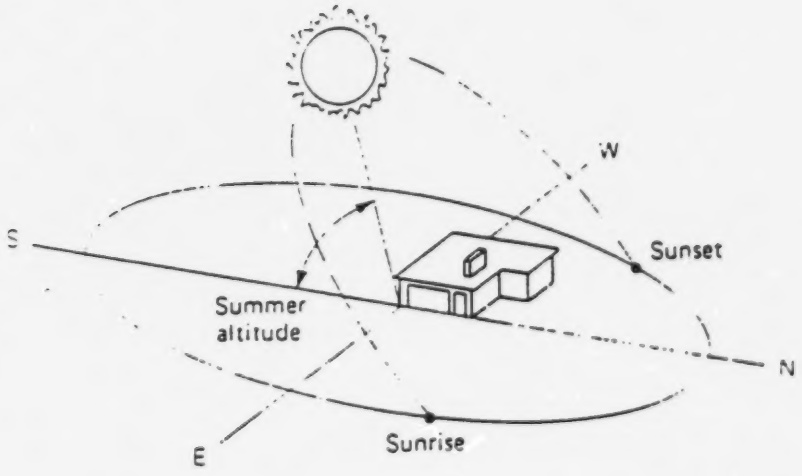
4. ENERGY SOURCE FOR CROP DRYING

4. RENEWABLE

OH7

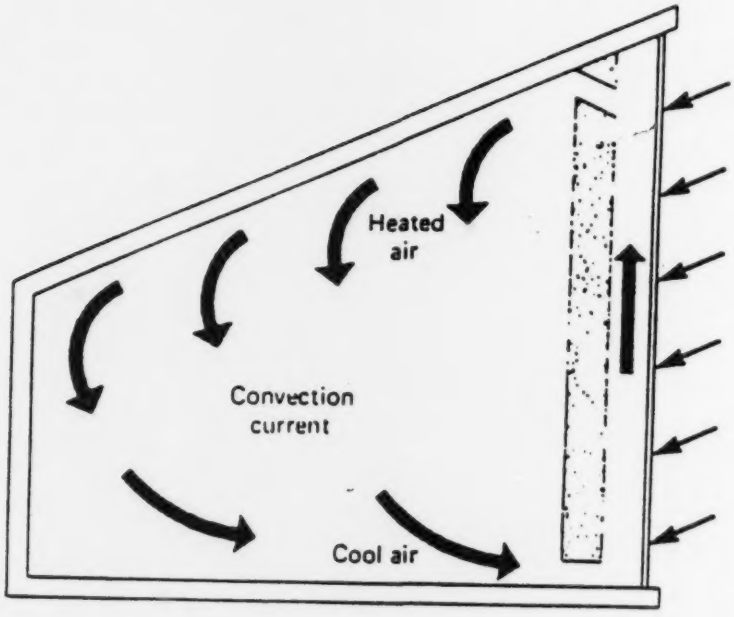
ALTITUDE OF THE SUN





OH8

TROMBE WALL



OH9

Solar Collector

1. SHAPED LIKE A FLAT BOX

2. SHOULD FACE SOUTH

3. PLACED AT AN ANGLE OF GEOGRAPHIC LATITUDE + 15^{o}

OH10

Photovoltaic Cells

1. RELEASES ELECTRONS WHEN LIGHT SHINES ON THEM

2. SMALL IN SIZE

3. PRODUCES SMALL AMOUNT OF ELECTRICITY

F. STUDENT HANDOUTS AND QUIZ

Student Information Guide

Work Sheet A

Work Sheet B

Work Sheet C

Work Sheet D

Student Activity Note Sheet

Student Activity - 1 Information Sheet

Student Activity - 1 Record Sheet

Student Activity - 2 Information Sheet

Quiz 1

STUDENT INFORMATION GUIDE

SOLAR ENERGY--AN ALTERNATIVE ENERGY SOURCE

Our lifestyles in today's world depend on fossil fuels: oil, natural gas and coal, in addition to nuclear energy to produce electricity, manufacture and transport products, and heat our homes. If we continue using fossil fuels in the manner we have grown accustomed, they will eventually be depleted. Our modern lifestyles require a great deal of energy. Even with conservation measures, alternative sources will still need to be utilized.

Some of the more popular alternative energy forms include: Geothermal, Tidal energy, Biomass, Synthetic Fuels, Water, Wind, and Solar Energy. Most of these energy sources do depend on the sun as an energy source.

Geothermal energy and tidal energy do not depend on the sun as an energy source. Geothermal energy is a natural energy source from the earth's molten core. In some areas of known geothermal activity, wells have been drilled to tap the energy. The energy comes to the earth's surface as water and steam and can turn the turbines for electric generators.Tidal energy is caused by the gravitational pull and the movement of the earth and moon. Tidal energy can be tapped by trapping water behind a dam when the tide comes in or out. The water is then released gradually and used to turn electric generators.

Most of us do not thingk of energy from biomass, synthetic fuels, water and wind as solar energy, but all these energy sources depend on the sun as an energy source. Without the sun, these energy sources would not exist. By using energy from biomass, synthetic fuels, water, and wind we really are using solar energy and solar energy byproducts.

Biomass is the remains, waste, or by-products of living things. It is utilized as an energy source by combustion and is the oldest source of energy known. The production of biomass energy is dependent upon solar energy. The sun provides the energy needed for photosynthesis to occur. It is an easily renewable energy

source. Biomass resources include wood and other forest materials, grain crops, plant residues such as cobs, husks, and stalks, animal manures, food-processing wastes, and aquatic plants. (Research in biomass presently includes propagating plants which grow quickly (ex. silver maples trees), production of those plants on wide scale acreage, and harvesting of the plants for large scale biomass operations.

Synthetic fuels are liquid and gaseous fuels made from non-petroleum sources. Ethanol and methanol are two major types of liquid alcohol. When ethanol is combined with gasoline, it is know as gasohol. Ethanol is obtained from grain crops such as corn. After the grain crop is harvested, it is heated, and the sugars and carbohydrates in the grain are allowed to ferment. Alcohol is then derived from the fermenting grains. Methane can be used as a motor fuel. Methane is a major part of natural gas and can be produced synthetically and used like natural gas. Ethanol, methanol, and methane are renewable energy sources and can be made from wood and forest materials, grains, and agricultural wastes. The prospect of the wide use of ethanol, methane, and methanol is especially attractive to American farmers because they could then produce fuel as well as food.

Water can be used as an alternative energy source in a couple of ways. The energy from water moving downhill in a stream can be harnessed and used as a source of electric power. The energy can be derived from the water naturally moving downhill, like a waterfall or from man-made dams. Water can also be used as a solar collector, or solar pond in warm climates of the world that also have naturally large deposits of salt. Heat energy is stored in the salt water at the bottom of the solar pond. The use of water as an alternative energy source is dependent on the sun to provide rain and heat. Water is a renewable source of energy.

Wind is caused by the sun's uneven heating of the surface of the earth. Windmills are used in various places of the world to harness the energy from the wind. Traditionally in our country, windmills have been used to pump water from wells. Before the wide spread use of electricity throughout the countryside, windmills were used to pump water for human and livestock use. Today windmills are still use to pump water from wells for livestock use, especially in remote areas. Wind is also being used as an alternative energy source by individuals who generate electricity to meet their own needs and sell any surplus power to the electric company. Some electric companies have set up many windmills together as wind farms and are also using wind to generate electrical power. The wind is a renewable energy source.

Solar energy is direct energy from the sun. Radiation from

the sun can be used for heating, generating electricity, and drying of agricultural crops. It is a completely renewable energy source.

SOLAR ENERGY

Solar energy, or radiation from the sun is an alternative energy source that has been of great interest to our society. There is more than enough energy from solar radiation reaching the earth for the world's energy needs. In the United States, an average of 177 watts of solar radiation strike each square meter of land. This average amount is considerably smaller than the actual amount of solar radiation reaching the earth under ideal conditions, due to darkness and the sun's angle. The amount of solar energy varies with the time of the day, season, weather, and geographic location. In order for solar energy to be useful to us as a constant energy source it must be collected and stored.

Solar energy can be used for our primary activities that demand energy. Solar energy can be used for space heating. It can be used to heat homes, barns, livestock confinement systems, farm shops, greenhouses, and many other buildings. Solar energy is also used for hot water heating, for drying of agricultural crops, and for generating electricity.

Angle of the Sun

It is important to know the angle the sun strikes the earth in order to collect solar radiation. The angle of solar radiation varies with season and latitude.

The earth rotates on an axis that runs through the North and South poles. The earth completes a full 360^0 rotation every 24 hours as it orbits around the sun, giving us our day and night. The sun appears to rise in the east and set in the west.

The polar axis is tilted at 23.5^0, causing sunlight to strike the earth more directly in the summer than in the winter. This causes the sun to appear higher in the sky in the summer than in the winter.

At the same time the earth is rotating on its polar axis, it is making an elliptical orbit around the sun. The northern part of the rotating earth tilts away from the sun in the winter and toward the sun in the summer. As a result, the days are longer in the summer than in the winter and the shadows are shorter in the summer than they are in the winter.

In the Northern hemisphere, the least amount of solar energy is available in the winter and the most is available in the summer. Unfortunately, winter is when heating requirements are the largest and summer is when heating requirements are the smallest.

Using Solar Energy as a Heat Source for Heating Space
Two basic methods can be employed when using solar energy for space heating of a building. Passive solar energy is a method which uses no mechanical pumps or motors to circulate heat. Active solar energy does require a fan or pump to circulate heated air or water within the building. A disadvantage of using solar heat as a heat source is that buildings must be designed for solar heating when they were built or in an extensive remodeling job.

PASSIVE SOLAR HEATING SYSTEM
In a passive solar heating system, buildings are designed to either let the sun in or keep it out. Orientation of a building (the direction it faces) is very important in the design of a building that is to be heated by solar energy. Solar energy enters a building through windows on the building's south side. The solar energy is converted into thermal energy and is circulated through the buildings using natural heat transfer methods of conduction, convection, and radiation.
A greenhouse is a good example of how solar energy enters a building through windows. A greenhouse uses transparent coverings such as glass, polyethylene, acrylic, and fiberglass for the major portions of its roof and walls. Solar energy enters the greenhouse primarily through its east, south, and west sides & the roof. The primary purpose of most greenhouses is to use the light energy that is transmitted through the roof and walls for the growing of plants. However by trapping light energy, greenhouses also trap a large amount of heat energy in all four seasons of the year. This is a real asset in the winter when it is cold outside and a real problem in the summer, when it can already by too hot for good plant growth. If a greenhouse is to be heated by solar energy alone, it needs a system to store the solar energy for future use just like any other building. Often times, water in black containers, walkways and floors are used to store heat energy. Because of a greenhouse's tremendous ability to trap energy, greenhouse-like structures are being used to provide a warm water environment in some aquaculture operations.

Windows can be covered with insulated coverings at night to reduce heat loss. Greenhouses often use thermal blankets or thermal curtains at night to cover a large area of benches where plants are grown to prevent heat loss. Roof overhangs screen unwanted sunlight in the summer and still allow the entry of sun in the winter.

Solar buildings can either be described as a direct or indirect gain solar building. In a direct (thermal) gain solar building, a part of the interior structure absorbs the solar radiation and stores it. Concrete, brick, or stone are good storage materials that can be incorporated into floors, a wall, or chimney.

In an indirect gain solar building, the energy absorbing materials are not part of the normal living or production area. The heat-storage materials are generally placed in a structure between south facing windows and the area that is being heated. Heat-storage materials include water in black containers, brick, or concrete. The solar energy absorbed by the storage structure is radiated into the living space by convection. A Trombe wall is one popular indirect gain system. Another popular indirect gain system uses an attached greenhouse on the south side of a building.

ACTIVE SOLAR HEATING SYSTEM

In an active solar heating system, solar energy is collected and stored in an area away from the area where it will be used. Pumps or fans are used to circulate heated water or air to the area where heat is needed. An active solar heating system can be used as a primary or secondary source of heat for homes, livestock confinement operations, and other agricultural buildings. Solar collectors are usually used to collect solar energy in an active solar heating system.

Solar collectors are generally shaped like a flat box. They are placed at an angle on the roof or on the ground to collect solar energy. Usually they are placed facing south, at an angle that equals geographic latitude plus 15^0. In Southern Illinois for example, collectors would be 37^0 (for 37^0 N) + 15^0 = 52^0.

Sunlight enters the solar collector through a transparent cover plate. A black metallic absorber plate is heated by entering sunlight. Circulating water or air is used to remove the thermal energy from the absorber plate. The thermal energy is then transferred to a storage area or to the area where heat is needed by pumps or fans.

Solar Hot Water Heating

Solar hot water heating can be adapted by most conventional homeowners, even those who cannot easily utilize solar space heating because their existing homes were not designed for it. It can also be used in many businesses. Some examples of businesses that use solar heated water are: agricultural processing plants, greenhouses during the winter, and aquaculture operations.

When water is heated by solar energy, a system using solar collectors similar to the ones used in an active solar space heating system are used. Water can be heated in the solar collector and then returned to a storage tank until it is ready to be used.

Drying Agricultural Crops with Solar Energy

The use of solar energy to dry agricultural crops dates back in history to the beginning of farming. Many crops need to be dried in order to prevent spoilage during storage. Grain crops such as corn, beans, wheat, and oats have long been dried in the field by solar energy and then

harvested when the crops were at or near the correct moisture level. Solar grain dryers can be used to dry the grain crops after they are harvested.

Hay is a good example of a crop that depends on solar energy for drying. When hay is harvested, the grass or legume, such as tall fescue, clover, or alfalfa, are mowed and allowed to dry on the ground on the field. The weather has a direct affect on the time it takes for the hay to dry. During hot, windy, sunny days, the hay can be at the correct moisture level for storage ia one day, while during damp, humid, cloudy days it may take several days to dry the hay. Sometimes a hay rake is used to turn the hay over on the ground to speed up the drying time. After the hay has dried to the correct moisture level, it can be harvested and stored.

Other crops are dried to prolong their use, such as some of the floricultural crops which are dried and then used in dried flower arrangements. Still, other agricultural crops are preserved by drying during processing. Fruits, vegetables, and nuts may be dried to preserve them and then packaged into a number of packaged trail mixes and dehydrated mixtures.

Generating Electricity with Solar Energy

One method of generating electricity with solar energy is by the use of photovoltaic cells, or solar cells. Some materials release electrons when light shines on them. Materials that have this property include selenium, silicon, germanium, and cadmium sulfide. Cells made of these materials are called photovoltaic cells.

Photovoltaic cells consist of a layer of semiconductor such as silicon. The front of the silicon is coated with a thin, transparent conducting film. The back of the silicon is coated with a thicker conducting aluminum layer. When sunlight strikes a photovoltaic cell, electrons flow between the two conducting layers and creates an electrical current. The current can be stored in a battery.

Photovoltaic cells are small and are about as thick as a dime. They produce only a small amount of electricity. They can be linked together to create a larger amount of electricity.

Photovoltaic cells are currently being used as an energy source for everyday items such as calculators, wristwatches, and exposure meters in cameras. They can generate enough energy to power electrical fence chargers for electric fences. Electric fences have an electrical current running through them and are used to fence in livestock. Photovoltaic cells are also used in orbiting satellites and spacecrafts to partially fulfill their energy needs.

GLOSSARY OF SCIENTIFIC TERMS:

active solar heating system - uses pumps to remove thermal energy from a solar collector and uses pumps to circulate heat within the building

conduction - type of heat transfer in which heat moves through a material without the material itself moving

convection - type of heat transfer in which heat moves through a material by actual movement of the material

direct gain solar building - building in which the interior structure absorbing the solar radiation is part of the living area (ex. wall, chimney, fireplace)

indirect gain solar building - building in which the energy-absorbing unit is not part of the living area, but a structure between the south-facing windows and the living area

passive solar heating system - solar heating system which uses no mechanical pumps for circulating heat

photovoltaic cells - solar cell

radiation - pure energy that moves through space

semiconductor - a substance used as in transistors to control electron flow

solar cell -	device that releases electrons which creates an electrical current and produces electrical energy, when the sun strikes it.
solar collector -	devise used to collect solar energy (ex. flat-plate collector, water)
solar energy -	radiation from the sun
solar pond -	pond containing heavily salted water from which heat does not escape
thermal energy -	heat energy
Trombe wall -	wall that is 8 - 18 inches thick and is placed 4 inches from a south-facing double thickness glass window

WORK SHEET A

DIRECTIONS: Complete the following questions.

1. Sources of energy other than fossil fuels are known as _____.

2. The alternative energy systems of Biomass, Synthetic Fuels, Water, Wind, and Solar Energy are all dependent on the ____.

3. _____ is a natural energy source from the earth's molten core that comes to the earth's surface as water and steam.

4. _____ can be tapped by trapping water behind a dam when the tide comes in or out and then used to turn electric generators.

5. _____ is the remains, waste, or by-products of living things and is utilized as an energy source by combustion.

6. Biomass energy is dependent upon solar energy because the sun provides the energy needed for _____ to occur in plants.

7. Biomass resources are easily _____.

8. _____ are liquid and gaseous fuels made from non-petroleum sources.

9. Ethanol and methanol are two major types of _____ _____.

10. Ethanol, methanol, and methane are _____ energy sources and can be made from wood and forest materials, grains, and agricultural wastes.

11. The energy from water moving downhill in a stream can be harnessed and used as a source of _____.

12. _____ can also be used as a solar collector, or solar pond to store heat energy.

13. The use of water as an alternative energy source is dependent on the sun to provide _____ and _____.

14. _____ is being used as an alternative energy source by individuals who generate electricity to meet their own needs and sell any surplus power to the electric company.

15. _____ is direct energy from the sun.

16. In the United States, an average of _____ watts of solar radiation strike each square meter of land.

17. The amount of _____ available for people to use varies with the time of the day, season, weather, and geographic location.

18. In order for solar energy to be useful to us as a constant energy source it must be _____ and _____.

19. The angle of _____ varies with season and latitude.

20. In the _____, the least amount of solar energy is available in the winter and the most is available in the summer.

WORK SHEET B

Directions: The answers to the following fill-in-the blank questions are terms which have something to do with solar energy. Choose the term from the word list below that best answers each question. Each term may be used only once.

Word List:

active solar heating system
conduction
convection
direct gain solar building
indirect gain solar building
passive solar heating system
photovoltaic cells
radiation
semiconductor
solar cell
solar conductor
solar energy
solar pond
thermal energy
trombe wall

Fill-in-the blank:

1. A _____ is a device that releases electrons to produce electrical energy when the sun strikes it.

2. _____ is a type of heat transfer in which heat moves through a material without the material itself moving.

3. _____ is radiation from the sun.

4. Another term for solar cells is _____.

5. Pure energy that moves through space is called _____.

6. An _____ uses pumps to remove thermal energy from a solar collector and uses pumps to circulate heat within the building.

7. A type of heat transfer in which heat moves through a material by actual movement of the material is called _____.

8. A _____ has an interior structure absorbing the solar radiation as part of the living area.

9. A devise used to collect solar energy is known as a _____ _____.

10. _____ contain an energy-absorbing unit that is not part of the living area, but a structure between the south-facing windows and the living area.

11. A _____ is 8 - 18 inches thick and is placed 4 inches from a south-facing double thickness glass window.

12. Another name for _____ is heat energy.

13. A _____ contains heavily salted water from which heat does not escape.

14. _____ do not use mechanical pumps for circulating heat.

15. A substance used to control electron flow is called a _____ .

WORK SHEET C

DIRECTIONS: Complete the following questions.

1. _____ is a method which uses no mechanical pumps or motors to circulate heat.

2. _____ does require a fan or pump to circulate heated air or water within the building.

3. In Solar energy heating systems, solar energy enters a building through windows on the building's _____ side. The solar energy is converted into _____ and is circulated through the buildings.

4. _____, _____, or_____ are good thermal heat storage materials that can be incorporated into floors, a wall, or chimney of a building.

5. In an indirect gain system, solar energy absorbed by the storage structure is radiated into the living space by _____.

6. _____ are usually used to collect solar energy in an active solar heating system.

7. The _____ from the solar collectors is then transferred to a storage area or living area by pumps or fans.

9. Solar _____ heating can be adapted by most conventional homeowners.

10. When water is heated by solar energy, a system using solar _____ similar to the ones used in an active solar space heating system are used.

11. One method of generating electricity with solar energy is by the use of _____, or solar cells.

12. Photovoltaic cells consist of a layer of semiconductor such as _____.

13. When sunlight strikes a photovoltaic cell,_____ flow between the two conducting layers and creates an electrical current.

WORK SHEET D: STUDENT REVIEW

1. Name and describe 5 alternative energy forms.

2. When is the most solar energy available in the Northern hemisphere?

3. What is the difference between passive solar energy and active solar energy?

4. What is the difference between a direct (thermal) gain solar building and indirect gain solar building?

5. How is water heated in a solar hot water heating system?

6. What are photovoltaic cells?

7. Name 3 items that use photovoltaic cells as an energy source.

STUDENT ACTIVITY NOTE SHEET

List steps to follow:

1. Location of activity

2. Making a construction paper pocket

3. Reading a thermometer and shaking the temperature down

4. Positioning the pocket at different angles

STUDENT ACTIVITY - 1
INFORMATION SHEET

Comparing solar angles to maximize solar energy

a. **Purpose:** To determine how the angle that sunlight strikes an object effects the energy absorbed by that object. For example, it is important to know at what angle solar collectors should be placed, in order to collect maximum solar radiation.

b. **What Each Group of Students Needs:**

1 sheet of black construction paper
clear cellophane tape
thermometer
2 books or other supports
wristwatch

c. **Here's How:**

1. Work in your assigned group.

2. Get a sheet of black construction paper. You will be using it to make a pocket for your thermometer.

3. Fold the paper in half. Now, make 1/2 inch fold on the two sides of the paper. Tape the sides of the paper together to form the pocket.

4. Place a thermometer inside the pocket. (Put the bulb end of the thermometer in the pocket first.)

5. Put the pocket with the thermometer in a shady place for 5 minutes. After 5 minutes, check the temperature. Record all temperatures during this activity on Part B of the Activity Record Sheet - 1. Then shake down the thermometer and put it back into the paper pocket.

6. Move to a sunny location. Place a book or other flat object on the ground and lay the pocket with the thermometer on top of it. Record the temperature on the Activity Record Sheet - 1 after 5 minutes. Then shake down the thermometer and put it back into the paper pocket.

7. Use your books or other supports to position the pocket with the thermometer so it is standing straight up, perpendicular with the ground. Record the temperature after 5 minutes. Then shake down the thermometer and put it back into the paper pocket.

8. Position the pocket containing the thermometer, so the sun shines directly into the pocket. Record the temperature after 5 minutes.

9. Select a position for the pocket containing the thermometer, that you think will receive the greatest amount of solar radiation. After 5 minutes, record the temperature.

STUDENT ACTIVITY - 1
RECORD SHEET

A. Predictions:

1. Which position do you think will receive the must solar energy?

2. Which position do you think will receive the least solar energy?

3. What factors other than the angle of the sun may affect your results?

B. Data:

1. Describe the weather conditions at the time this activity was taking place.

2. Describe where the sun is located in the sky during this activity.

3. Record your data from the activity in the table below:

	TIME	ANGLE THAT SUN STRIKES THERMOMETER	TEMPERATURE
A. POCKET IN SHADY AREA			
B. POCKET LAYING FLAT ON BOOK			
C. POCKET STANDING STRAIGHT UP			
D. POCKET POSITIONED SO SUN IS SHINING INSIDE IT			
E. DESCRIBE HOW POCKET IS ANGLED			

C. Conclusions:

1. In which of the positions was the sunlight hitting the face of the pocket at the greatest angle?

2. In which of the positions was the sunlight hitting the face of the pocket at the smallest angle?

3. In which position was the highest temperature recorded? Why do you think the temperature was highest in this position?

4. In which position was the lowest temperature recorded? Why do you think the temperature was lowest in this position?

5. How does the angle of the sunlight striking an object affect the amount of solar energy it receives?

STUDENT ACTIVITY - 2
INFORMATION SHEET

DRYING HORTICULTURAL/AGRICULTURAL PRODUCTS

a. **Introduction:** Solar energy has long been used as an energy source for the drying of grains, vegetables, flowers and foliage, bulbs, and other agricultural crops. Some of the drying occurs naturally near harvest time when the crop is still in the field. In other cases, crops or seeds are harvested and placed in the sun to dry. There has also been a renewed interest in preserving food by using solar energy.

b. **Purpose:** To demonstrate how solar energy can be used as an energy source for drying horticultural products

c. **What Each Group of Students Needs:**
cardboard box similar to soda flat box
newspaper
plant material

d. **Here's How:**

1. Work in your assigned group.

2. Select the horticultural product you wish to try to dry. All horticultural products should be in good condition and approaching maturity. Some possibilities include:
   a. apple slices to be used on wreathes or decorations
   b. pumpkins, gourds or other fall fruit decorations
   c. flowers for pressing, especially thin flowers such as pansies, violets, & wildflowers
   d. foliage
   e. flowers that will maintain their shape such as roses, and strawflowers
   f. wild flowers gathered by the roadside
   g. bulbs

3. Prop your soda flat box up in a sunny spot. Place your box so the sun's rays will be shining into the box for most of the day. (Use information obtained in Activity 1.)

4. If materials are to be pressed, place between newspaper and weight with cardboard or heavy books.

5. Return the boxes with the plant material to the classroom over night. Return the boxes to the sun every day until plant products are dry, usually 3 - 7 days.

6. Examine your end result. Did solar energy dry the products? How would you change the drying schedule if you were to repeat the activity.

QUIZ 1

A: MATCHING:

_____1. Solar Energy

_____2. Passive Solar Heating System

_____3. Active Solar Heating System

_____4. Direct Gain Solar Building

_____5. Indirect Gain Solar Building

a. has interior structure absorbing solar radiation as part of the living area
b. uses mechanical pumps to circulate heat
c. radiation from the sun
d. does not use mechanical pumps to circulate heat
e. has an energy-absorbing unit located between the south-facing windows & living area, but is not an actual part of the living area

B: TRUE OR FALSE:

_____6. Energy from fossil fuels is known as alternative energy sources.

_____7. Biomass is a renewable energy source.

_____8. Ethanol, methanol, and methane are examples or non-renewable energy sources.

_____9. The angle of solar radiation varies with the season and latitude.

_____10. The amount of solar energy available for people to use varies with the time of day, season, weather, and geographic location.

C: FILL-IN-THE BLANK:

11. _____ such as ethanol, methanol, and methane are made from wood, grains, and agricultural wastes.

12. _____ is the remains, waste, or by-products of living things and is utilized as an energy source by combustion.

13. _____ energy is energy direct from the sun

14. The angle of _____ varies with season and latitude.

15. A _____ is a devise that is used to collect solar energy.

D: SHORT ANSWER:

16. Why is it important to know the angle of solar radiation in the winter?